



Underlying Principles for Joint Systems Studies of a New Aerospace Combat Capability

Terry Moon and
Michael O'Brien (contractor)

DSTO-GD-0241

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Joint Systems Branch
Electronics and Surveillance Research Laboratory

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ABSTRACT

The purpose of this paper was to identify the underlying principles that may be used to guide joint systems studies of a new aerospace combat capability for the ADF that is being considered under Project AIR 6000. From these principles broad systems attributes are identified. Assessments of these attributes are considered important for subsequent investment decisions and development of capabilities from a broad systems perspective. Methods for assessing the broad systems attributes identified will, however, be the subject of subsequent work.

RELEASE LIMITATION

Approved for public release

This document is written for information and discussion. The data and conclusions expressed in it are the work of the authors and do not necessarily represent the views of DSTO, the AIR 6000 Project Office or the Australian Department of Defence.

DEPARTMENT OF DEFENCE
DEFENCE SCIENCE & TECHNOLOGY ORGANISATION

DSTO

Published by

*DSTO Electronics and Surveillance Research Laboratory
PO Box 1500
Salisbury South Australia 5108 Australia*

*Telephone: (08) 8259 5555
Fax: (08) 8259 6567
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AR-011-449
May 2000*

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Executive Summary

Defence outputs currently include capabilities for air strike/reconnaissance and tactical fighter operations. These are provided by F-111 and F/A-18 aircraft and are estimated to cost almost A\$2 billion this financial year. It is estimated that the F/A-18 aircraft will reach the end of its life of type by about 2015 and the F-111 soon after.

Project AIR 6000 was initiated to look at the options for a new aerospace combat capability. In assessing options for future capabilities it is prudent to consider the level of Defence funding available and the demands to strike an appropriate balance between:

- Land, air and maritime forces.
- Current preparedness and future capability.
- The scale of forces Australia could deploy and the length of time for which they could be sustained.
- Establishing forces primarily for Australian defence and adapting them for participation in regional and international situations.

The purpose of this report was to identify the underlying principles that may be used to guide joint systems studies of a new aerospace combat capability for the ADF and identify the broad systems attributes to be assessed. A summary of the salient points follows.

1. There are some enduring tenets of Australian Defence policy and strategic planning that provide a sound basis for strategic outlook. These are:

- A regional focus and the primacy of the Defence of Australia.
- The policy of self-reliance in Defence.
- A stratagem of Defence in depth.
- A joint-services approach to military operations.
- The importance of coalition operations.

2. Assessment of the trends in the Australian Defence budget suggests that:

- Dramatic increases in Defence funding are unlikely.
- The capital equipment acquisition program is currently over-stretched.
- Personnel and operating costs are increasing.

- Bloc obsolescence of major (and expensive to replace) Defence capabilities will occur in the next two decades.

3. A review of international trends in air power uncovered the following common themes:

- An emphasis on joint and combined operations.
- Current fiscal constraints are expected to continue.
- The increased use of precision-guided and stand off weapons.
- Difficulty in retaining pilots.
- Use of multi-role aircraft.

Joint systems studies for the acquisition of a new aerospace combat capability should thus take into account a range of complex, and at times competing, strategic, economic, societal and political demands as well as the customary assessments and analyses of equipment options. The nature of military operations the ADF could be called upon to do, and the continuing relevance of tactical fighter and strike/reconnaissance operations for Australian Defence, should be established. Assessments of broad systems attributes such as affordability, interoperability, versatility and adaptability will be important for investment decisions on Project AIR 6000.

Authors

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Terry Moon obtained his BSc(Hons) from Monash University in 1975, MSc from the University of Melbourne in 1979 and PhD from Monash University in 1984. He has worked in astronomy and astrophysics, solar energy technology and Defence Science.

Since joining the DSTO in 1986 Terry has worked in the fields of electronic warfare technology, program evaluation, operations analysis, imaging radar and is currently working in the field of joint systems assessment.

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1. Introduction

Defence outputs currently include capabilities for air strike/reconnaissance and tactical fighter operations. These are provided by F-111 and F/A-18 aircraft and are estimated to cost almost A\$2 billion this financial year (Australian Bureau of Statistics 2000). It is estimated that the F/A-18 aircraft will reach the end of its life of type by about 2015 and the F-111 soon after.

Project AIR 6000 was initiated to look at the options for a new aerospace combat capability. In assessing options for future capabilities it is prudent to consider the level of Defence funding available and the demands to strike an appropriate balance between:

- Land, air and maritime forces.
- Current preparedness and future capability.
- The scale of forces Australia could deploy and the length of time for which they could be sustained.
- Establishing forces primarily for Australian defence and adapting them for participation in regional and international situations.

The purpose of this report is to identify the underlying principles that may be used to guide joint systems studies of a new aerospace combat capability for the ADF and identify the broad systems attributes to be assessed. The nature and extent of a new aerospace combat capability to meet the roles the ADF may be called upon to undertake will depend on a wide range of societal, political, economic and strategic factors. A major constraint will be the affordability of proposed options and a major consideration will be interoperability in joint and coalition operations.

Historical trends suggest that Defence expenditure is unlikely to increase unless Australia is at war. With a number of other major capabilities due for replacement over the next 20 years, a proposal for a new aerospace combat capability is likely to receive close scrutiny. This will include amongst other factors, its relevance to strategic policy, operational versatility and its affordability in terms of acquisition and sustainment costs.

2. Australia's Strategic Outlook

Since publication of Defence of Australia in 1987 Australia's published strategic policy has evolved significantly (DoA 87). From focussing solely on the development of capabilities to Defeat Attacks on Australia (DAA), the most recent published strategic policy recognises potential military roles for the ADF spanning a spectrum of conflict in scale, intensity and geographic location (ASP 97).

Although defeating attacks against Australia's territory remains the core force structure priority (and is the pre-eminent criterion for capability development); investment decisions may be influenced by the ability of Australia's military forces to also contribute to the task of Defending Regional Interests (DRI).¹

A new Defence White Paper is being drafted. The impact of this new White Paper on published strategic outlook and capability development is unknown. A recent media report, however, suggests that Government Ministers are opposed to an expensive high capability Defence Force that could provide a significant contribution to a major conflict in northern Asia (Taiwan or Korea) or fight wars beyond the "arc of instability" to our immediate north and east (Garren 2000). This arc encompasses Indonesia, Papua New Guinea and the Pacific Islands. Such thinking is not significantly different from the DRI strategy proposed in ASP 97 and flags the issue of ongoing fiscal restraint on Defence.

Despite some significant shifts in strategic policy there have been some enduring tenets to our strategic outlook.

2.1 Defence of Australia and a Regional Focus

It is recognised that Australia cannot undertake a global power projection role nor should it. Thus, since 1976, the basis of national strategy, the structuring of the Defence Force and the selection of equipment has been the defence of Australia.

A regional focus has resulted and is now an enduring theme in Australian strategic outlook. For example the pursuit of a 'knowledge edge' embraces the revolution in military affairs (RMA) that is occurring but recognises that, whereas the US seeks this advantage against any adversary anywhere in the world, Australia's scope is limited to its immediate strategic environment. Prevailing political, strategic, societal and economic circumstances (and limits to defence spending) are likely to reinforce this regional focus.

¹ It is recognised that the capabilities developed to meet these higher-priority tasks will provide the Government with a range of options to contribute to military operations supporting our Global Interests (SGI).

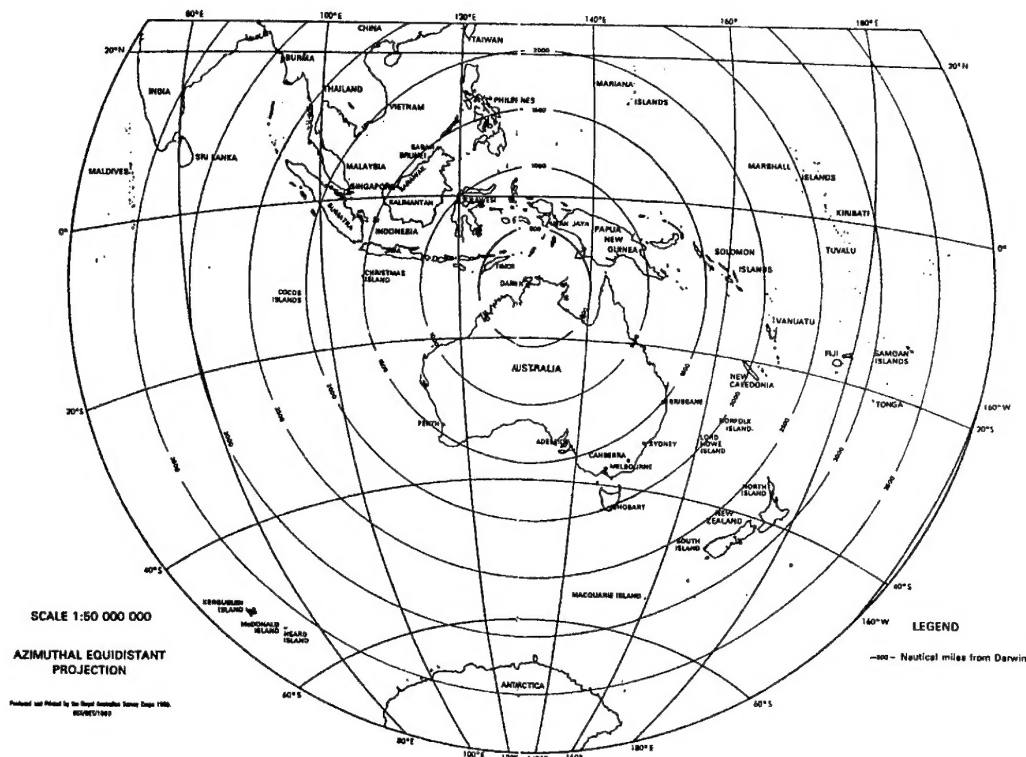


Figure 1. Australia's regional security interests. This map is an azimuthal equidistant projection and was produced by the Royal Australian Survey Corps. Similar views have appeared in AD 76 and ASP 97.

2.2 Self-reliance in Defence

The concept of self-reliance in defence has been a central feature of our strategic policy since the 1976 Defence White Paper (AD 76). It means that Australia must be able to defend its territory without relying on the combat forces of other countries. Here the distinction is drawn between self-sufficiency, where all military capabilities would need to be fully supported from within Australia, and the concept of self-reliance where Australia can undertake independent military action with capabilities that may be sourced from overseas but supported through local industry involvement and a network of allies. Appropriate Australian industry involvement in defence has thus become a major part of the Government's Defence policy. This is likely to continue.

For a new aerospace combat capability important issues would include through-life support of equipment, availability of spare and replacement parts from overseas suppliers, access to software code and resupply of expendables. There is likely to be a premium applied for modification or tailoring of equipment comprising sophisticated and complex technologies.

2.3 Defence in Depth

The sea-air gap (SAG) to our north provides a natural impediment to an adversary attacking the Australian mainland. The employment of a range of capabilities within and across the sea, air and land environments would further complicate the planning and conduct of attacks on Australia. Development of suitable complementary capabilities that enable the ADF to control the Sea Air Gap (SAG) in the event of an attack on Australia is central to this concept of defence in depth. The challenge is to integrate the individual capabilities acquired into a system of systems with the emergent properties needed.

2.4 Joint Operations

The concept of joint operations involving components of sea, air and land forces is well established and is a key consideration in defence capability development. Joint operations form the cornerstone of ADF force structure and doctrine. This is unlikely to change. New capabilities should thus be able to be readily used in joint operations.

2.5 Coalition Operations

Historically Australia has undertaken many military operations as part of a coalition. The importance of our relationships with our long-standing allies is formally recognised in our Defence policy. Coalition operations with allies may thus be regarded as an enduring key planning assumption for our strategic outlook. Coupled with the posture of self-reliance, this calls for capabilities that can be easily used with allies and coalition partners as well as independently.

3. Military Conflicts

3.1 Range of Operations

The ADF may be called upon to undertake both operational and non-operational roles associated with the application of military power across a wide spectrum of conflict. An indication of the range of potential operations is given in Figure 2.

PEACE	OOTW	WAR
Emergency relief	Peace enforcement	
Support to civil authorities	Peacekeeping	Local conflicts
Counter-terrorism	Sanctions	Regional wars
Evacuation	Humanitarian aid	General war

Figure 2. Range of potential military operations for the ADF.

Although the ADF may, and has, been called upon to supplement the civil emergency services in times of exceptional demand, it does not normally provide these services to the civil community. There are two standing exceptions to this principle. The first is the provision of specialist support to counter-terrorist operations. The second is support to customs, immigration, fisheries and other civil authorities by providing surveillance and response forces in Australia's coastal waters.

In peacetime the ADF may also be called upon to conduct an evacuation of Australian nationals from a volatile situation overseas when Australian interests are engaged. In recent years Australian governments have often faced decisions about deployment of elements of the ADF to undertake humanitarian operations overseas. These are usually in response to United Nations initiatives and reflect Australia's role as a responsible member of the international community. Australian forces may also be called upon to undertake a range of peacekeeping and peace enforcement operations. Being overseas conflicts, where Australia is not one of the protagonists, these are classed as operations other than war (OOTW).

War could range from low-intensity conflicts through to a general war with wide geographic extent and involving many nations.

3.2 Constraints on Operations

Significant societal and political constraints apply to the use of military force by the ADF. Australia places negotiation ahead of force in situations of rising political tensions, with force as an option when diplomatic measures have been exhausted.

Australia also has strict codes of practice for waging war. These include avoiding civilian casualties and destruction of property as well as minimising casualties among Australian and coalition forces and loss of materiel. Australia does not employ weapons of mass destruction and, in a conflict, would aim to keep to a minimum any environmental damage.

International opinion and media scrutiny have, and would continue to, act as significant constraints on Australian military operations.

The rules of engagement for Australian forces during conflicts are thus very complex. Resulting from this, and the increasing societal and political constraints, is a clear trend towards the acquisition of precision-guided munitions and stand off weapons.

3.3 Threats

The key judgement in the 1980s was that we could expect significant warning, up to 10 years, of the development of a direct threat to launch a major attack on Australia. A sobering view is, however, given by Evans (1990) when he points to an Australian study that has shown average warning times are typically about 14 months for high-level conflict months and about 10 months for smaller conflicts. It is worth noting here that, in recent times, the coup in Fiji was unexpected, we had only short warning (less than a year) of the trouble in East Timor, the Asian economic crisis was largely unexpected and current events in Indonesia appear to have taken us by surprise.

The subject of warning time is both a complex and vexed issue. The approach adopted has thus been to differentiate between crisis and capability warning times. Crises are inherently unpredictable and their warning times may be very short. It could also be difficult to judge when a situation is likely to lead to a crisis involving armed conflict.

On the other hand it may be argued that it would take some years for a regional state to develop appropriate and substantial military capabilities for attacking Australia and this development would be difficult to hide. Substantial warning time of the development of a threat capability would then be available and could be used to determine priorities for force development.

In the current absence of a clearly defined enemy, or nations with an adversarial stance and intent, the approach has thus been to examine the broad regional military capabilities that could be brought to bear against Australia. In examining these capabilities it is important to include a range of factors in addition to the available military equipment.

Assessments based solely on inventories of military equipment could be misleading. Instead a systems approach should be taken. These would include force structure, doctrine, military organisation, logistics and support, operational competence and training, ability to sustain military operations, access to resupply, economic resources, societal and political support, and supporting industry infrastructure.

3.4 The Enemy as a System

Although specific enemy equipment or installations may be prosecuted as targets, the overall aim in a military conflict would be to remove or negate the enemy's ability to

undertake military activities against Australia. It is thus important to maintain an holistic perspective of the enemy as a total entity where their ability to undertake military operations against Australia is an emergent property of their total military system, supported by their national infrastructure and economy and backed by societal and political directives. In addition the interaction of the enemy system with our military system should be considered.

Aspects of the enemy as a system may be broadly placed into five categories (Directorate of Doctrine and Development 1999). These are:

1. Enemy command and leadership. This includes both military and political leaders and support to their decision-making and command processes.
2. Support systems. Power, command and communications networks, civilian telecommunications and information technology systems are included in this category.
3. Key infrastructure. Included here are transport networks, distribution and supply centres and key industrial installations or complexes.
4. Popular will. The media, influential people and political pressure or power groups all influence a nation's will to wage war.
5. Fielded military forces. These include equipment, personnel, organisation and doctrine.

4. Air Power

4.1 Doctrine

Australia's application of air power is described in several publications, covering doctrine at the strategic, operational and tactical levels of war (Air Power Studies Centre 1998; Directorate of Doctrine and Development 1999; RAAF Group/Wing Standing instructions).

Strategic-level doctrine establishes the fundamental principles that guide the ADF for employment of air power in pursuit of national objectives (Air Power Studies Centre 1998, p.4).

Operational-level doctrine is concerned with the planning and conduct of campaigns (Directorate of Doctrine and Development 1999).

Tactical-level air power doctrine provides the procedural basis for detailed mission planning and execution of air tasks (RAAF Group/Wing Standing instructions).

Air power doctrine should be considered in the development of a new aerospace combat capability and should, in turn, be reviewed when new capabilities are being sought and, if necessary, revised when they are introduced into service.

4.2 Core Air Power Capabilities

4.2.1 Control of the air

An effective control of the air capability is essential if ADF assets are to operate unhampered by the threat of hostile air attack. The degrees of control of the air are broadly classified as (Air Power Studies Centre 1998; Directorate of Doctrine and Development 1999):

- Local air superiority (or favourable air situation) results when control of the air is applied for a limited period of time and over a given area. The aim is to ensure that enemy air power does not pose a serious threat to one's own population, national infrastructure or international lines of communication, or to one's own air, land or sea operations.
- Air superiority is achieved when control of the air dominates enemy air power to the extent that one's own air, land and sea operations can be undertaken at specific times and locations without interference by enemy air forces.
- Air supremacy applies when enemy air power does not present a threat to national interests, or one's own air, land and sea operations.

Control of the air is considered as comprising two components (Air Power Studies Centre 1998, Directorate of Doctrine and Development 1999):

1. *Offensive counter-air (OCA)* focuses on the neutralisation of the enemy's air power to ensure control of the air for one's own air forces. Targets for OCA may include enemy air defence systems, aircraft in the air or on the ground, air and ground crews, command and control systems, air bases and supply and storage areas.
2. *Defensive counter-air (DCA)* actions aim to deny an enemy control of the air by nullifying or reducing the effectiveness of their hostile air action.

4.2.2 Precision strike

Precision strike is the ability to use air power to destroy or neutralise targets and to undermine the enemy's will to fight through the application of firepower with a high degree of lethality, discrimination and accuracy.

4.2.3 Precision engagement

Precision engagement is the ability to locate and engage enemy elements without directly applying firepower. It may be used as a precursor to control of the air or precision-strike operations. Activities such as tracking or shadowing land and naval assets, surveillance and reconnaissance, airborne insertion and extraction or a fighter sweep are typical examples of precision engagement.

4.2.4 Rapid force projection

Rapid force projection is the deployment of air power to locations in or near an area where the Government wishes to exert strategic influence on the basis of force. In particular deployment to bases in northern Australia that forms an arc of operating locations across Australia's northern approaches.

4.2.5 Information exploitation

This involves the use of aerospace power to provide knowledge required for the conduct of successful air, land and sea operations. The aim is to derive the greatest possible knowledge about the enemy and any neutral forces while keeping similar knowledge of one's own forces from the enemy.

An information exploitation capability encompasses:

- Using aerospace power to gather data from airborne surveillance and reconnaissance systems.
- Translating that data into information.
- Fusing that information with information available from other sources.
- Collating, analysing, storing and communicating salient information to the relevant commanders, their staff and combatants.
- Using the knowledge derived from the information effectively and quickly to determine appropriate responses and optimise any subsequent military operations.

5. New Aerospace Combat Capability

5.1 Current Air Combat Capability

Current Defence output capabilities include tactical fighter operations (provided by F/A-18 aircraft) and air strike/reconnaissance (provided by F-111 aircraft).

The F/A-18 entered service with the RAAF during the period 1985-90 but is yet to be used in active service. Currently there are 71 operational F/A-18 aircraft. The RAAF Tactical Fighter Group operates F/A-18 aircraft from Williamtown and Tindal air bases (two aircraft are operated by the RAAF Aircraft Research and Development Unit). The F/A-18 aircraft are capable of air-to-air refuelling using the ADF's B707 tanker and other drogue-fitted allied refuelling aircraft.

The strike capability resides with 17 F-111C and 12 operational F-111G aircraft. In addition the four RF-111C aircraft provide a limited reconnaissance capability. Twenty-six years after its introduction into service in 1973 the F-111 saw active service for the first time in East Timor. Commencing in November 1999 RF-111s flew photoreconnaissance missions over East Timor in support of InterFET. The flights,

continuing through to 9 December 1999, were, however, undertaken in an essentially benign air environment (Bayliss 2000). The F/A-18 and F-111 aircraft are expected to reach the end of their life-of-types (LOT) by 2015 and 2020 respectively. Extensive weapons and electronic warfare upgrade programs are planned to maintain an effective capability.

5.2 Scenarios

Detailed scenarios may be developed for studying the application of air power in specific circumstances. Although current and past situations can be modelled in considerable depth, and suitable data can usually be found, the relevance to future conflicts of the results obtained may be questioned.

Capabilities that would enter service in the future could be assessed against the basic tasks the ADF could be called upon to do. (Currently these are categorised as defeating attacks against Australia, defending our regional interests and supporting Australia's global interests.). Strategic guidance, however, evolves and the lead times for introduction of new or enhanced capabilities are usually long (a decade or more). Furthermore life of type (LOT) of major equipment can be long, typically in the order of 25 to 50 years. The tasks the ADF will be expected to undertake in the future could thus be significantly different from those of today. Given these time frames, and the likely evolution of ADF tasks, capabilities should be adaptable (to new tasks). An ability to contribute to more than one ADF task would also be beneficial.

Forecasts of strategic outlook can also provide broad indications of potential situations where the ADF may be called upon to act. Such forecasts, however, contain considerable uncertainties that increase as we extend the time horizon of the forecast. Another approach is to explore basic missions of interest that we expect to be undertaken in conflicts now and in the future (e.g., hunting a high-value mobile target or suppressing an enemy's air defence system) and develop concepts of use for technologies and capabilities that could become available. An assessment of the efficacy of the various options in this concept of use can then be undertaken.

There is a diverse range of potential options for a future aerospace combat capability. To properly examine these options strategic outlook, the possible nature of future warfare and the types of missions the ADF could be called upon to undertake should all be taken into account. Thus a combination of these approaches may be needed to thoroughly explore the capability options and gain sufficient insight for making important investment decisions.

5.3 Roles

Tasks for the ADF may be broadly categorised as defeating attacks on Australia (DAA), defending regional interests (DRI), protecting Australia's national interests (PNI) and

supporting its global interests (SGI). Furthermore the current priorities for force structure development are (ASP 97):

1. The knowledge edge.
2. Defeating threats in our maritime approaches.
3. Strike.
4. Land forces.

In a resource-constrained environment, a new aerospace combat capability would need to contribute substantially to Priorities 2 and 3. It may be argued that it should also provide an auxiliary contribution to Priorities 1 and 4.

In terms of core air power capabilities, the some possible roles for a new aerospace combat system are shown in Table 1.

Table 1. Possible Roles for a new aerospace combat capability

ADF Tasks	CORE AIR POWER CAPABILITIES		
	CONTROL OF THE AIR	PRECISION STRIKE	PRECISION ENGAGEMENT
DAA	Counter air operations	Strategic and Maritime strike	<ul style="list-style-type: none"> • Surveillance and Reconnaissance • Sweep operations
DRI/PNI	Counter air operations	Interdiction	Surveillance and Reconnaissance
SGI	<ul style="list-style-type: none"> • Counter air operations • SEAD* 	<ul style="list-style-type: none"> • Strategic and Maritime strike • Offensive Air Support • Interdiction 	<ul style="list-style-type: none"> • Surveillance and Reconnaissance • Sweep operations

*Suppression of Enemy Air Defences.

5.4 Fiscal Considerations

5.4.1 The Defence budget

Historically Australia has had low levels of Defence spending in times of peace with dramatic and rapid increases during times of conflict. It has been noted (Vamplew 1987) that such a 'boom or bust' approach to Defence preparedness has, at times, weakened Australia's capacity to counter threats.

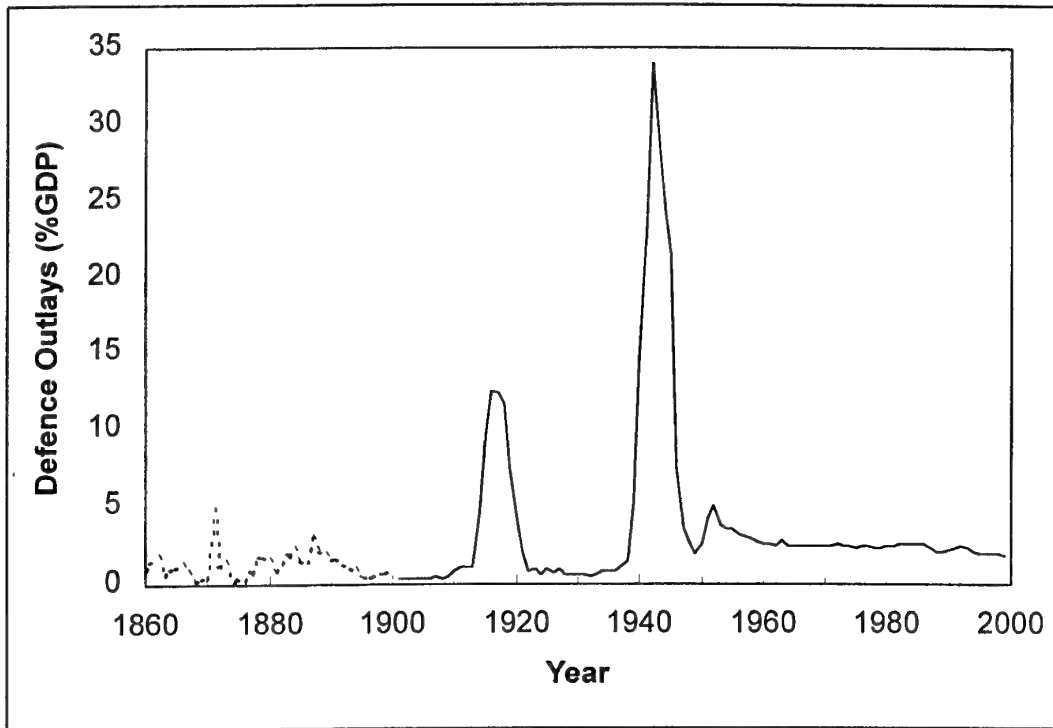


Figure 3. Australian Defence outlays. Aggregate Defence outlays (as a percentage of Gross Public Capital Formation) for the Australian colonies prior to Federation are shown as a dotted line (Vamplew 1987). Figures for Defence expenditure as a percentage of GDP since the 1901-02 financial year are from RFP (1999).

Figure 3 shows that current Defence expenditure is at its lowest level since the 1938-39 financial year. The historical trends would suggest that significant increases in Defence outlays are unlikely to occur in the current continuing period of peace.

For the 1999-2000 financial year Defence expenditure is estimated to be a little more than A\$11 billion of which a little less than A\$3 billion will be spent on new equipment. This is indicative of the annual level of funding expected for the foreseeable future. Over the next 10 years it may thus be expected that there will be approximately A\$30 billion dollars to cover all new capital equipment acquisitions.

The envisaged bloc obsolescence of current platforms and systems, starting around 2007, and the inability of the current level of Defence funding to meet new major capital equipment proposals, are reported by Bostock (2000), Julian (2000) and Wall & Thomas (2000). They note that existing procurement plans for combat aircraft, helicopters, ships and Army equipment are estimated to cost about A\$88-106 billion over the next 20 years. A recent proposal for a broad range of airlift aircraft, arising from recent experience in East Timor, would further increase this estimated cost.

Woolner (1999) discusses the Defence budget and outlines the current and imminent fiscal problems. Foremost among these are:

- Burgeoning labour costs. Net personnel and operating costs (NPOC) have been increasing at a substantial rate. This has been exacerbated by the tendency of new capabilities to cost more to operate than the budget can accommodate easily. Despite the reduced size of the ADF, personnel costs will remain a critical driver for the defence budget.
- Accumulated commitments for new capabilities. Throughout the 1990s Defence has been accumulating commitments for new major capital equipment at a rate 50% greater than it has increased the relevant annual appropriation.
- Looming bloc obsolescence. A number of major defence capabilities will reach their end of life of type (LOT) within the next 20 years. The tactical fighter and air strike/reconnaissance are just two of these.

The juxtaposition of these problems is likely to lead to:

- An increased scrutiny of proposals for acquiring new major capital equipment.
- Even closer alignment of Defence priorities with strategic policy.
- A re-appraisal of current force structures, doctrines and organisation.
- Changes to procurement policies, procedures and priorities.
- The management of through-life support.

Any acquisition of a new aerospace combat capability must therefore be fully justified and properly managed. Internationally, smart procurement and development initiatives are being explored (Gjetnes 1997, Schwartz 1997). Any acquisition of a new aerospace combat capability should take into account these developments and could benefit from the application of such approaches as multi-stage acquisition and evolutionary development.

5.4.2 Cost of manned combat aircraft

At the International Aerospace Congress 1999 (IAC 99), Air Vice Marshall Peter Nicholson highlighted the dramatic increase in the cost of manned combat aircraft that has occurred since the Second World War (Ferguson 1999). For example the P-51 Mustang used by the RAAF 50 years ago cost US\$50 000 then. This would equate to about US\$540 000 today. In 1962 the F-111 aircraft were priced at US\$3.4 million each, equivalent to about US\$18 million today. By the time they were delivered to Australia, the cost had risen threefold. The newest generation combat aircraft, the F-22, are estimated to cost about US\$ 200 million each. Thus there has been a more than 300-fold increase in the price of a latest-technology, frontline, manned, combat aircraft since World War II. Murphy (1999) similarly refers to dramatic increases over time in the acquisition cost of tactical aircraft. He observes that formations of manned bombers appear to be extinct tools of warfare and opines that manned fighter aircraft are heading that way!

It is worth noting that the proceeding discussion considers manned aircraft acquisition cost only. The total cost of ownership is much greater. Nicolai (1997) claims that for a manned fighter aircraft the acquisition cost represents about 40% of the ten-year life cycle cost (LCC). Schwartz (1997) uses recent historical data (on the F-22, B-2, F-15E, and the F/A-18 C/D, E/F aircraft) to estimate that procurement costs represent 58% of the total LCC but notes that these recent programs have been characterised by low procurement quantities and rates.

The bulk of LCC for military hardware is usually in operation and support (O&S). The Defence Systems Management College (1990) gives a nominal cost distribution for a US Department of Defence program. Typically 10% of the LCC can be attributed to system research and development (R&D), 30% to production and 60% to operation and support. The acquisition cost is production plus R&D costs and is then typically 40% of the LCC. It is, however, noted that O&S costs have risen in the US at a rate greater than 3% per annum.

Clearly, through-life O&S costs can exceed acquisition costs for advanced military hardware and should be considered in investment decisions for new capabilities.

5.5 Pilots

Currently the RAAF has a shortage of pilots and difficulty retaining them. Forecasts of demographic trends indicate that families are having fewer children and hence the pool of young people to recruit from is decreasing. Given this trend, it may in the future become even more difficult to recruit and retain sufficient numbers of pilots. As personnel are considered a vital component of force structure, it is important that a new aerospace combat capability addresses the increasing difficulty and cost of recruiting, training and retaining, in particular, pilots and, in general, skilled personnel.

5.6 Broad systems attributes

Broad systems attributes for a new aerospace combat capability that are consistent with an approach taking into account strategic outlook, broad defence tasks, doctrine and fiscal considerations, should include:

- Affordability, i.e. whether the cost of ownership of the proposed system is within a budget that is consistent with political and societal expectations and overall levels of defence funding.
- Interoperability with other services, allies and coalition partners.²

² ADFP 101 defines interoperability as 'the ability of systems, units or forces to provide the services to and accept services from other systems, units or forces and to use the services so exchanged to enable them to operate effectively together.'

- Versatility to undertake a wide range of operations effectively and the ability to complement or augment other capabilities.
- Adaptability to new operations and environments that could arise as the nature of warfare, and responses to it, evolve. This includes development potential (i.e. capacities for upgrading, modernising, restructuring, reconfiguring or replacing systems).³

These should be of prime consideration in joint systems studies for a new aerospace combat capability.

6. The Future of Air Power: An International Perspective

In this era of globalisation it is recognised that Australia is an integral part of the international community. To that end an assessment of overseas trends would be prudent. In addition Australia's strategy of self-reliance rather than self-sufficiency means that major capital equipment for our defence may be sourced from overseas. In choosing such equipment it may become necessary to keep modifications to a minimum to ensure that the systems acquired are affordable.

During 1999 the magazine, *Military Technology*, conducted a questionnaire-based survey on 'The Future of Warfare' (MILTECH 1999a-f). The following questions were asked of the Chiefs of Staff of the World's air forces:

1. *In general terms, i.e., independent from the specific tasks and missions of your service, how would you assess the overall significance and development of air power at the dawn of the 21st century?*
2. *Coming now to your own service, what is the air force's role within the overall framework of the defence policy of your country?*
3. *There is a general trend for the armed forces of industrialised countries to be increasingly re-orientated towards intervention missions abroad. Is this trend also affecting your service? If so, what steps are being or will be implemented in this regard? And, how can these new missions be reconciled and combined with the priority task of ensuring protection of national air space?*
4. *The effectiveness of an air force is heavily dependent on the existence of adequate industrial structures to develop and produce advanced weapon systems such as combat aircraft. There are currently but three countries that can still develop and produce their own fighters on a purely national basis, and this will go down to two and possibly one with the new aircraft generation. At the same time, the industrial scene is being completely changed by a series of mergers and acquisitions. What is your view of this process? Do you regard it as a positive or rather a negative development?*

³ Adaptability is the ability of systems, units or forces to readily adapt to new circumstances, environments or types of military conflict and continue to operate effectively.

5. Which percentage of the overall defence budget is currently being assigned to the air force? Do you see, or would you like to see, changes ahead?
6. Many air forces in the world are facing a personnel retention problem, as pilots leave the service to pursue higher salaries and better career prospects with civil airlines. Is this problem also affecting your service? If so, where do you think the solution lies?
7. In terms of materiel, what are the main procurement programmes you are currently pursuing, or formulating, for the near/medium future?

Their replies were published progressively (MILTECH 1999a-f) and show some common themes despite the substantial variations in the sizes, geo-political situations, cultures and economic circumstances of the respective air forces. The common themes are:

- An emphasis on joint and combined operations. Many respondents saw a growing trend to providing contributions to UN-initiated, multi-national crisis management operations and other Defence alliances. As a consequence interoperability of forces has become a major issue and many nations are endeavouring to better integrate their land, sea and air forces and also improve their ability to readily undertake coalition operations.
- Fiscal constraints. For the nations responding to the MILTECH survey the proportion of their Defence budgets allocated to air forces generally varied between 20 and 30% (see Figure 4) with most respondents not expecting substantial increases in the foreseeable future. Some respondents were expecting a 'quality versus quantity' debate given the increasing costs for new equipment.

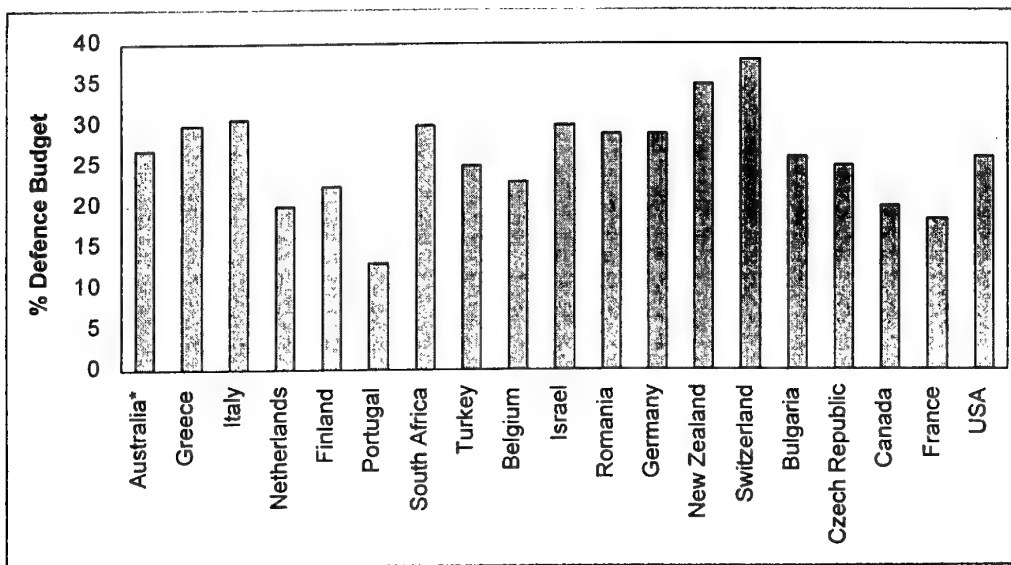


Figure 4. Histogram of % defence budget allocated to air forces. The percentage allocated to the RAAF was estimated from 1999-2000 Budget estimates for those Defence Outputs managed by the RAAF (Australian Bureau of Statistics 2000).

- Increased use of precision-guided munitions and stand off weapons. Societal and political demands for minimising casualties and avoiding collateral damage are providing the impetus for increased acquisition and use of precise weapons that can be launched and directed from afar.
- Pilot retention. Many of the air forces had difficulty in retaining pilots despite implementing a range of strategies.
- Use of multi-role aircraft. Acquisition of multi-role aircraft is seen as a means of maintaining versatility to undertake a wide range of operations and adaptability to new situations in times of fiscal constraint.

Currently there appears to be some significant similarities between Australian and overseas perspectives of air power. It could thus transpire that affordable and suitable systems are developed overseas that, with little or no modification, would be suitable as a new aerospace combat capability for Australia. As affordability is likely to be a major consideration, it is important to keep track of international developments in air power capabilities.

7. Conclusions

There are some enduring tenets of Australian Defence policy and strategic planning that provide a sound basis for strategic outlook. These are:

- A regional focus and the primacy of the Defence of Australia.
- The policy of self-reliance in Defence.
- A stratagem of Defence in depth.
- A joint-services approach to military operations.
- The importance of coalition operations.

Assessment of the trends in the Australian Defence budget suggests that:

1. Dramatic increases in Defence funding are unlikely.
2. The capital equipment acquisition program is currently over-stretched.
3. Personnel and operating costs are increasing.
4. Bloc obsolescence of major (and expensive to replace) Defence capabilities will occur in the next two decades.

A review of international trends in air power uncovered the following common themes:

1. An emphasis on joint and combined operations.
2. Current fiscal constraints are expected to continue.
3. The increased use of precision-guided and stand off weapons.
4. Difficulty in retaining pilots.

5. Use of multi-role aircraft.

Joint systems studies of a new aerospace combat capability should take into account a range of complex, and at times competing, strategic, economic, societal and political demands as well as the customary assessments and analyses of equipment options. The nature of military operations the ADF could be called upon to do, and the continuing relevance of tactical fighter and strike/reconnaissance operations for Australian Defence, should be established. Assessments of broad systems attributes such as affordability, interoperability, versatility and adaptability will be important for investment decisions on Project AIR 6000.

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Terry Moon & Michael O'Brien

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				1. PRIVACY MARKING/CAVEAT (OF DOCUMENT)	
2. TITLE Underlying Principles for Joint Systems Studies of a New Aerospace Combat Capability			3. SECURITY CLASSIFICATION (FOR UNCLASSIFIED REPORTS THAT ARE LIMITED RELEASE USE (L) NEXT TO DOCUMENT CLASSIFICATION) Document (U) Title (U) Abstract (U)		
4. AUTHOR(S) Terry Moon & Michael O'Brien			5. CORPORATE AUTHOR Electronics and Surveillance Research Laboratory PO Box 1500 Salisbury SA 5108 Australia		
6a. DSTO NUMBER DSTO-GD-0241		6b. AR NUMBER AR-011-449		6c. TYPE OF REPORT General Document	
				7. DOCUMENT DATE May 2000	
8. FILE NUMBER N9505-19-85	9. TASK NUMBER AIR 00/018	10. TASK SPONSOR DGAD	11. NO. OF PAGES 30	12. NO. OF REFERENCES 29	
13. DOWNGRADING/DELIMITING INSTRUCTIONS none			14. RELEASE AUTHORITY Chief Information Technology Division		
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17. CASUAL ANNOUNCEMENT Yes					
18. DEFTEST DESCRIPTORS Joint systems studies Interoperability Defence planning Futurology Air power Australian Defence Force					
19. ABSTRACT The purpose of this paper was to identify the underlying principles that may be used to guide joint systems studies of a new aerospace combat capability for the ADF that is being considered under Project AIR 6000. From these principles broad systems attributes are identified. Assessments of these attributes are considered important for subsequent investment decisions and development of capabilities from a broad systems perspective. Methods for assessing the broad systems attributes identified will, however, be the subject of subsequent work.					